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Part of #13

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

THOMAS A. GENISE

Application No: 08/666,164 Group Art Unit:

Filed: June 19, 1996 Examiner:

For: AUTOMATED TRANSMISSION SYSTEM CONTROL WITH ZERO ENGINE FLYWHEEL TORQUE DETERMINATION

AFFIDAVIT OF THOMAS A. GENISE

I, Thomas A. Genise do hereby state:

1. I reside at 449 N. Lafayette, Dearborn, Michigan 48128.

2. My educational background includes a Bachelor of Science degree in Mechanical Engineering (B.S.M.E) from the University of Michigan - Dearborn, and a Masters of Science Degree in Mechanical Engineering (M.S.M.E) also from the University of Michigan - Dearborn.

3. Since January of 1982, I have worked for Eaton Corporation in the Corporate Research and Development - Detroit Center (CORD-DC). Since 1988, I have worked as a systems engineer managing project teams.

4. As a systems engineer at Eaton Corporation, my responsibilities include designing and developing new truck transmission systems utilizing microprocessor electronics to fully or partially automate manual transmissions. My responsibilities

further include designing and developing mechanical components for transmissions, and developing and utilizing computer vehicle simulation programs.

5. In August 1993, I received a telephone call from James McReynolds who wanted to discuss the possibility of developing a partially automated transmission system which he called "AutoStick".

6. McReynolds explained that he would like Eaton Corp. to develop a transmission system which provides the driver with many of the conveniences of a fully automated transmission such as clutchless and throttleless shifts, but which is not much more expensive that a manual transmission system because the shift lever is maintained.

7. In particular, McReynolds explained to me that the "AutoStick" transmission would include a shift lever, a shift button which the driver would depress in order to upshift or downshift. In response to depressing the button, the system would automatically defuel the engine to minimize torque, thereby allowing the driver to move the shift lever to neutral without using the clutch pedal. After the system senses neutral, the system would thereafter calculate the synchronization speed for the next gear, and control the engine to approach the synchronization speed for the next gear.

8. On September 7, 1993, I received a specification (Exhibit B) from McReynolds which describes the partially automated system.

9. The name "AutoStick" was re-named as "AutoSplit", and on November 15, 1993, I sketched on an electronic white board three options of how AutoSplit could be implemented during a meeting at CORD-DC. Exhibit C is a copy of those three sketches. Options 1, 2 and 3 show a manual transmission, a display unit for displaying the different gear ratios, an engine control unit for controlling the engine and a stick shift having a switch pad (options 1 and 3) or up/down buttons (options 2) for initiating the shift. I explained that in response to the driver depressing the switch pad or up/down buttons, the engine control unit controls engine fueling so as to reach a zero torque level, thereby allowing the driver to move the shift lever to the neutral position. I further explained that after neutral was sensed, the engine control would control engine fueling to approach the synchronization speed for the next gear.

not shown in sketches

10. On December 9, 1993, I prepared a project proposal for a concept AutoSplit, called "Electronically Enhanced Super 10". Exhibit D is a copy of the December 9, 1993 proposal. Exhibit D includes several options for implementing AutoSplit including different versions of the intent-to-shift switch.

11. In April-May 1994, I began working on the AutoStick transmission project which was renamed as "AutoSplit". I was the project manager and systems engineer for the AutoSplit project. On May 13, 1994, I prepared with the assistance of Bill Mack, an "AutoSplit Specification for the Concept Prototype". This Specification defined the general requirements for the AutoSplit

concept prototype. Exhibit E is a copy of the AutoSplit Specification document.

12. My responsibilities in connection with the AutoSplit project included leading the project, designing the system and software requirements including algorithm design, and determining system requirements. My responsibilities also included preparing specification requirements, project/program plans, and technical reports in connection with the AutoSplit transmission system.

In August of 1994, a prototype of the AutoSplit transmission system was completed and implemented in a ten speed Freightliner truck. This AutoSplit prototype was successfully tested during a three day extensive road trip between August 29-31, 1994.

The three day trip originated from Southfield, Michigan and included stops at Marshall, Michigan and Traverse, Michigan. The test driving team included Ron Markyvech, John Dresden III, and myself.

13. The AutoSplit transmission system prototype that was successfully tested between August 29-31, 1994 was implemented in a Freightliner truck which included an engine, an engine output shaft, an engine Electronic Control Unit (ECU) for controlling the engine speed and other engine parameters, a transmission ECU for controlling the engine ECU through a SAE J1939 communication data link, a ten-speed transmission, a master clutch connected between the engine and the transmission, and a clutch pedal for controlling the master clutch. The Freightliner truck also included

transmission input and output shaft speed sensors, a manual stick shift for allowing the driver to manually shift the transmission between the ten different speed ratios, a display panel mounted on the shift lever for displaying the presently engaged gear and the next gear, and a laptop computer acting as an operator intent-to-shift control switch or button for sending a signal to the transmission ECU indicating whether an upshift or a downshift is to be initiated as the next gear shift, and for requesting that the engine be fueled to minimize driveline torque allowing easy disengagement of an engaged ratio without requiring disengagement of the master clutch. For example, an upshift was initiated when the operator depressed the intent to shift switch while an upshift was being displayed on the display, and a downshift was initiated when the operator depressed the intent to shift switch while a downshift was being displayed. The operator intent-to-shift switch initiated the upshift or the downshift by first signalling to the transmission ECU a desire to eliminate torque between the engine output shaft and the transmission output shaft. Based upon receiving the operator intent to shift signal, the transmission ECU modified the engine fueling to reduce torque to the transmission. The operator could then easily shift the transmission to neutral. Based upon receiving the intent to shift signal, and after sensing that the transmission was shifted to neutral, the transmission ECU then controlled the engine to achieve a substantially synchronous engine speed necessary for the next gear ratio. Attached as Exhibit 4 is a block diagram of the AutoSplit transmission system. This

block diagram is an accurate representation of the prototype tested between August 29-31, 1994.

14. The hardware elements of the AutoSplit prototype tested between August 29-31, 1994 have since been re-configured for use in other transmission systems. However, Exhibits 5-11 are photocopies of the actual hardware elements used during the August 29-31, 1994 trip. Specifically, Exhibit 5 is a photocopy of the actual ten-speed transmission used in the test. Exhibit 6 is a photocopy of the actual transmission ECU, Exhibit 7 is a photocopy of the actual engine and engine ECU, Exhibit 8 is a photocopy of the actual electrical wiring harness, Exhibit 9 is a photocopy of the actual display panel which was mounted on the shift lever, Exhibit 10 is a photocopy of the actual master clutch foot pedal, and Exhibit 11 is a photocopy of the actual truck used during the August 29-31, 1994 trip.

15. The AutoSplit transmission system tested during the August 29-31, 1994 trip included several software engine control routines. These software routines were implemented in the transmission ECU. Exhibit 12 is a printout of the actual software code contained in the transmission ECU during the August 29-31, 1994 test trip. The front page of Exhibit 12 identifies the dates of the various files contained in the software program, with the latest date being August 29, 1994. I assisted Ron Markyvech in preparing the software program of Exhibit 12.

16. As indicated above, the software program of Exhibit 12 includes several software engine control routines. One such routine

is able to predict or determine zero flywheel torque based on system variables, and then modify engine fueling to achieve the zero torque condition. The zero torque condition enables the driver to easily move the transmission out of gear engagement and into the neutral position. The software program of Exhibit 12 includes module "drl_cmds.c96" which contains the function "determine_shiftability_variable" and the function "needed_percent_for_zero_flywheel_trq". These functions serve to predict a zero flywheel torque based on system variables. The function "control_intent_to_shift" and the function "intent_final_pct_trq" which are also contained in module drl_cmds.c96 serve to modify engine fueling such that a zero torque condition exists. In particular, the function intent_final_pct_trq serves to ramp the torque down to the zero torque value. During the road test trip of August 29-31, 1994, Ron Markyvech connected his laptop Personal Computer (PC) to the communication data link of the AutoSplit system. This allowed the PC to display the predicted torque percentage for achieving zero flywheel torque. During testing on the road trip, Ron commanded intent_final_pct_trq to equal the predicted torque percentage as well as other torque percentages. Once the zero torque condition existed, the transmission was manually moved out of gear engagement and into a neutral position.

17. During the August 29-31, 1994 road trip, the AutoSplit transmission system was extensively tested by monitoring data on displayed on Ron Markyvech's Personal Computer (PC). In

particular, the testing included monitoring the torque values after the intent-to-shift switch was recognized by the transmission ECU; identifying when the transmission was shifted into neutral; monitoring the various engine control parameters in different modes of operation including the (torque control mode and speed control mode); and monitoring the transmission input shaft speed. The testing also included evaluating data at the time the transmission shifted into gear and considering the "feel" of the shift for purposes of determining shift quality. During the road test trip of August 29-31, 1994, the AutoSplit performed well during these tests.

18. During the development of the AutoSplit transmission system, Ron Markyvech and I periodically gave technical presentations about our progress to engineers at Eaton's Truck Components Operations North America (TCONA) division. These presentations included a discussion of structure and operation of the AutoSplit transmission system including a discussion of the software operation.

19. The AutoSplit transmission prototype described above was subsequently demonstrated to engineers of Eaton's TCONA Division on January 11, 1995. The demonstration occurred at Eaton's proving grounds in Marshall, Michigan. Ron Markyvech and I performed the demonstration. The Eaton TCONA engineers that attended the demonstration included John Steeby and Warren Dedow. During the demonstration, John Steeby and Warren Dedow each drove the truck. The AutoSplit transmission prototype performed well during this

demonstration operating in the torque and speed control modes during different shift sequences.

20. The AutoSplit transmission system demonstrated on January 11, 1995 was basically the same system tested during the road trip of August 29-31, 1994. One difference between the two systems concerned the shift lever. In the system tested between August 29-31, 1994, the top portion of the shift lever contained a display for displaying the currently engaged gear and the next expected gear (see Exhibit 9). In the system demonstrated on January 11, 1995, the display was a separate device mounted on the truck's console. Exhibit 15 is a photocopy of the actual display used at the January 11, 1995 demonstration. Another difference between the two systems concerned the shift lever. In the system tested during August 29-31, 1994 trip, the shift lever did not contain the driver intent-to-shift switch. Rather, during the August 29-31, 1994 trip, Ron Markyvech connected his PC to the system's communication data link and entered the intent-to-shift command by depressing keys on the keyboard of the PC. In the system demonstrated on January 11, 1995, a new shift lever was implemented which included an intent-to-shift switch or button. Exhibit 16 is a photocopy of the shift lever with the intent-to-shift button.

21. There was also a modification to the software that was demonstrated on January 11, 1995. Exhibit 18 is a copy of the software code implemented in the transmission ECU that was demonstrated on January 11, 1995. According to this code, function

sequence_shift will call function shift_initiate which will set engine_commands to ENGINE_PREDIP which then calls function control_engine_predip to control the engine torque parameter to zero as a function of predicted zero torque.

22. On February 21, 1995, I prepared a Technical Report regarding the AutoSplit Transmission prototype. Exhibit 21 is a copy of the February 21, 1995 Technical Report. The Technical Report includes descriptions of the various control algorithms, and also provides plotted data of system parameters taken during actual vehicle shift testing. As indicated on the cover page, this Report was widely distributed.

23. The AutoSplit transmission system was also demonstrated on July 14, 1995 at Eaton's proving grounds in Marshall, Michigan. I demonstrated the AutoSplit transmission system on July 14, 1995 to engineers and upper management of Eaton Corporation including Steven Edelen of TCONA. Attached is a Travel Expense Report that I submitted on July 17, 1995 for the travel I conducted the week of July 10, 1995 which included the July 13-14, 1995 demonstration trip . The "Purpose of Trip" section of the Report indicates that on July 13 and 14, I demonstrated the AutoSplit to TCONA management. The AutoSplit transmission system included the same hardware components and operated according to the same software structure described above in connection with the AutoSplit transmission system demonstrated on January 11, 1995. The AutoSplit transmission system worked well during the demonstration and impressed upper management. Attached as Exhibit 20 is a memo

from William A. Baken dated July 17, 1995 setting forth the "Automation Strategic Planning Meeting Minutes" for the July 14, 1995 meeting/demonstration. The third page of the memo indicates that I demonstrated the AutoSplit Concept Truck. Attached to the memo there is a copy of the Agenda for the July 14, 1995 meeting/demonstration. The Agenda indicates that ride and drive demonstrations were available at 7:00 am and 1:00 pm on July 14, 1995.

24. During the period of time from the beginning of July 1995 through the end of June 1996, I worked as a systems engineer at Eaton Corporation's Corporate Research & Development Center in Detroit, Michigan (CORD-DC) in the automated transmission development program for heavy duty vehicles. During this time period, the automated transmission program included related projects under the names "AutoShift","AutoSplit" and"Top Two". These projects were all transmission systems utilizing dynamic clutchless shifting wherein mechanical transmissions could be shifted using engine controls without requiring the operator to utilize the clutch and/or throttle pedal. Further, these projects had essentially the same or similar software structure for purposes of automating and/or assisting a transmission shift sequence. For example, each of these projects included software for automatically controlling the engine fueling to achieve zero flywheel torque for shifting into neutral from a gear to be disengaged, and to achieve engine synchronization speed for engaging a target gear ratio. During the period of time from the beginning of July 1995 through

the end of June 1996, I continuously worked on developing products for heavy duty trucks in Eaton's automated transmission program. Specifically, as indicated in the table below, the majority of my time on a monthly basis between July 1995 and June 1996 was spent on developing products from the AutoShift/AutoSplit/Top-Two automated transmission projects. The total number of hours spent on product development activity between July 1995 and June 1996 was:

July '95	111.0 hours
Aug. '95	108.5 hours
Sept.'95	111.0 hours
Oct. '95	159.5 hours
Nov. '95	162.5 hours
Dec. '95	121.0 hours
Jan. '96	172.5 hours
Feb. '96	135.5 hours
Mar. '96	119.0 hours
Apr. '96	95.5 hours
May '96	80.5 hours
June '96	110.5 hours
Total	1,487 hours

The following sets forth some of the development activities I was involved in from July 1995 through June 1996:

25. On July 12, 1995, I travelled to Galesburg, Michigan to attend a J1939 data communication link meeting. On August 22, 1995, I prepared a Functional Performance Specification for the AutoSplit

project (exhibit 25). On August 30, 1995, I distributed an AutoSplit Design Specification sheet (exhibit 26). This document states that "TACONA has identified the AutoSplit transmission concept as an integral part of their automatic product strategy". On September 29-29, 1995, I travelled to Galesburg, Michigan to attend an automation team meeting. On September 30, 1995, I prepared Revision 1.0 of the AutoSplit Product Design Specification (exhibit 27). On October 12, 1995, I travelled to Milford, Michigan to grade test the AutoShift transmission system. On October 30, 1995, I prepared a Project Closing Record (exhibit 28) which indicates that revisions to the AutoSplit development will be continued under another project. This document means that the funds allocated for AutoSplit development were used up, but that further allocation was provided under another project so that the AutoSplit development can continue. I also prepared on October 30, 1995, a revised AutoSplit Design Specification (exhibit 29).

26. Between November 1-3, 1995, I travelled through northern Michigan test driving the AutoShift transmission system. On November 17, 1995, I prepared a revised Functional Performance Specification for the AutoSplit project (exhibit 30). On November 13 and 28, 1995, I travelled to Galesburg and Southfield, respectively, test driving the AutoShift transmission. On November 22, 1995, I traveled to Traverse City, Michigan, testing driving the 7 speed AutoShift system. On December 5, 1995, I travelled to Marshall, Michigan test driving the Top 2 truck. On December 20, 1995, I travelled to Galesburg, Michigan, for a demonstration of

the AutoShift transmission system.

27. On January 16, 1996, I travelled to Milford, Michigan, test driving the AutoShift. On January 31, 1996, I travelled to Galesburg, Michigan to demonstrate the AutoShift software and meeting with TCONA people. My January 1996 Monthly Report states that during this month, the AutoShift Shift algorithm was modified to include skip shifting, and was made more adaptive to actual engine braking effectiveness. My February 1996 Monthly Report indicates that on February 7, 1996, the modified AutoShift software that include skip shifting was demonstrated. Further, during this month, a task was added to evaluate a modified pneumatic inertia brake used to speed up shifting, and test software was written that allows the AutoShift truck to be used as the stationary test stand. On February 27, 1996, I travelled to Kalamazoo, Michigan to attend a Top 2 team product development meeting. My March 1996 Monthly Report - which mistakenly states that it is for the month of February - indicates that on March 26, 1996, a meeting was held to discuss a method of routing pressurized oil from the transmission internal oil pump. The Report also indicates that during March 1996, software regarding the SEL_GEAR module was written, incorporated into the Mack system and tested. My March 1996 report entitled "AutoShift Support" also mentions the oil routing method for the AutoShift transmission. On March 29, 1996, a trip was made to Dearborn, Michigan to obtain hardware supplied for the Volvo AutoSplit Truck.

28. My April 1996 Report indicates that during this month an

AutoSplit system was installed in a Volvo truck and demonstrated on April 19, 1996 to people in TACONA. My April 1996 Report entitled AutoShift Support indicates that a new test was prepared that uses the integral oil pump in the transmission.

29. My May 1996 Monthly Report indicates that approximately 80 percent of the software code needed for the Mack Top Two has been designed, written, compiled and integrated into the bench top system. On May 16, 1996, I made a trip to Galesburg, Michigan to discuss the AutoShift project. On May 22, 1996, I made a trip to Mack Truck, Inc. to discuss the Top 2 project. On May 15, I prepared a document entitled "Volvo AutoSplit RetroFit" (exhibit). The purpose of this document was to document our efforts on installing the AutoSplit transmission system in a vehicle for demonstration and evaluation purposes. On May 28, 1996, I travelled to Galesburg, Michigan to discuss the AutoShift project. Further, my May 1996 Report entitled "AutoShift Support" indicates that during this month plans were being made with TCONA to continue testing and development of 25 AutoShift units.

30. My June 1996 Monthly Report indicates that development on the AutoShift system continued. Further, on June 13, 1996, I travelled to Southfield, Michigan to obtain supplies for the AutoSplit installation. On June 18, 1996, I travelled to Warren, Michigan, in connection with the AutoSplit truck. On July 1, 1996, I travelled to Marshall proving grounds for an AutoSplit demonstration.

I declare under punishment of perjury under the laws of the United States of America that the foregoing is true and accurate.

8-28-97
Date

Thomas A. Genise
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